January 5, 2007

Sitec Environmental Inc.
769 Plain Street Suit Unit C
Marshfield, MA 02050

Attention: Mr. Mike Quatromoni

Subject: Perimeter Berm Stability
Crow Lane landfill
Newburyport, Massachusetts

Gentlemen;

In accordance with your request, we are providing geotechnical engineering services associated with the Crow Lane landfill located in Newburyport, Massachusetts.

PROJECT BACKGROUND

We understand that New Ventures Associates, LLC, as part of a Corrective Action Design, is constructing a berm around the perimeter of the landfill to establish a system of swales to convey storm water from the landfill to detention basins. The berm is to also provide a stable base for regrading the landfill. Existing waste was pushed back from wetlands abutting the landfill, so that the edge of waste is within the limits defined by the berm.

The maximum height of the perimeter berm will be about 43 feet. The average outboard slope is relatively steep (1H: 1V) and was designed with armored slope protection (18-in. thick). The berm was to be constructed using structural fill, consisting of processed crushed concrete (3-inch max. size) or crushed rock (6-inch max. size). We understand that soft, organic soils, that were known to exist in the abutting wetlands, were removed from beneath the proposed berm footprint area prior to berm construction.

Currently the berm is partially complete. GZA Geoenviromental performed static and seismic stability analyses for the current berm geometry. However, it appears that a different material was used to construct the berm. On 3 April, 2006 Mr. Dick Stulgis (GEOCOMP Corporation) visited the site and observed conditions in 18 machine-excavated test pits that had been performed through the top of the berm around the perimeter of the landfill by New Venture Associates. The test pits ranged from several feet to in excess of 8 ft. deep. Generally, processed construction and demolition debris materials, with varying amount of fines, was observed in the test pits. Samples were collected and delivered to GEOCOMP Corporation. Samples collected included the soil-size fraction of materials without the larger pieces.

You requested that we provide a review and recommendations for impacts on the design resulting from the change in berm materials.

SCOPE

The scope of the work included in the items covered in this letter report includes:

1. Review the material used in constructing the berms, recommend and perform laboratory tests to assist in evaluating impacts on the design.
2. Provide letter report with recommendations for design modifications to berm to accommodate the changed materials.

The work considers only the stability of the 1H:1V berm slope with a different material. We have assumed the same berm foundation conditions as used in the GZA analysis.

LABORATORY TESTING

Geotesting Express Inc. performed 11 gradation tests on the soils collected from the perimeter berm. The data sheets for the tests are attached. The following table summarizes the results.

Summary of Particle Size Analysis

Sample Name	% Cobble	%Gravel	%Sand	%Silt & Clay Size
P2-3	-	50	37	13
P2-6	-	37	48	15
P2-9	-	69	24	8
P1-3	7	49	34	10
P1-6	-	55	35	10
P1-9	-	51	40	9
P16-3	0.3	95	4	1
P16-6	-	45	49	6
P16-9	-	51	36	14
P16-12	17	36	35	12
P16-15	-	48	38	14

Typically the soil comprising the berm is brown silty gravel with sand, AASHTO Classification A-1-a Stone fragments, Gravel and Sand with larger pieces of crushed concrete, bricks and stones.

To determine the strength of the materials for the stability analysis and design of the berm, we are currently performing a Large Direct Shear test, and a compaction test on the samples. The results for these tests are not currently available. For the analysis presented in this letter, we have assumed an internal friction angle of 38 degrees for the berm soils.

PERIMETER BERM STABILTY

The strength of the materials that comprise the perimeter berm will be influenced by the presence of the silty gravel and sand that infill the voids in the crushed concrete. Although no strength data is currently available for this material, we believe that the strength for the as-built berm material is less than that assumed by GZA in their stability analysis. For the analysis performed for this report ,we have used a friction angle of 38 degrees for the structural fill in the perimeter berm. This will be confirmed by laboratory strength tests.

Minimum acceptable factor of safety values of 1.3 and 1.5 were adopted for global stability and bearing capacity failure modes, respectively, in the analyses. To achieve this factor of safety we have flattened the slopes to 1.5H:1V. The geometry is restrained by the proximity of the wetland and property boundary at the toe of the slope, and the already placed waste at the crest of the slope. In most locations it is not feasible to construct the entire berm height at the 1.5H:1V slope. We therefore steepened the upper portions of the berm using Mechanically Stabilized Earth (MSE) construction. In MSE construction geosynthetic reinforcement is placed in layers and is used to provide a reinforcing tensile force to improve the factor of safety.

The attached figure presents a summary of the design and analysis. The elevation of the toe point of the MSE portion of the berm corresponds to the existing berm elevation on the site. This elevation varies around the perimeter of the landfill. The analysis shown in the attached figure represents the location where the berm height is the greatest. The figure shows potential slip zones thru the berm, color coded with the factor of safety. The red zone indicates the most critical zone of sliding. The minimum factor of safety of the berm shown in the figure is 1.34.

RECOMENDATIONS

The following can be concluded from the analyses:

1. Continuing to fill at a slope of 1H:1V will not meet the minimum acceptable factor of safety.
2. The existing berm slopes should be flattened to a 1.5H:1V to meet the existing height of the berm. We understand that in some locations and where the berm heights are less than approximately 20 feet that 1.5H:1V slopes may not be feasible. At these locations we recommend that the slopes be buttressed using individually placed boulder rip-rap, with a maximum thickness at the base of the slope.
3. To complete the berm along the westerly side of the landfill from its existing height to the proposed final elevations, and meet the geometrical constraints, we recommend Mechanically Stabilized Earth (MSE) berms be constructed, as shown in the attached figure. MSE construction techniques are also recommended for the southerly berm which is currently designed for construction at a 1H:1V slope.

This work and its conclusions are based on information and data provided by Sitec Environmental. Our conclusions and recommendations are predicated on this information and data being accurate, complete and representative. Should additional information exist or become available which could alter the information and data provided to us, or the interpretation of such, our conclusions and recommendations should be reconsidered.

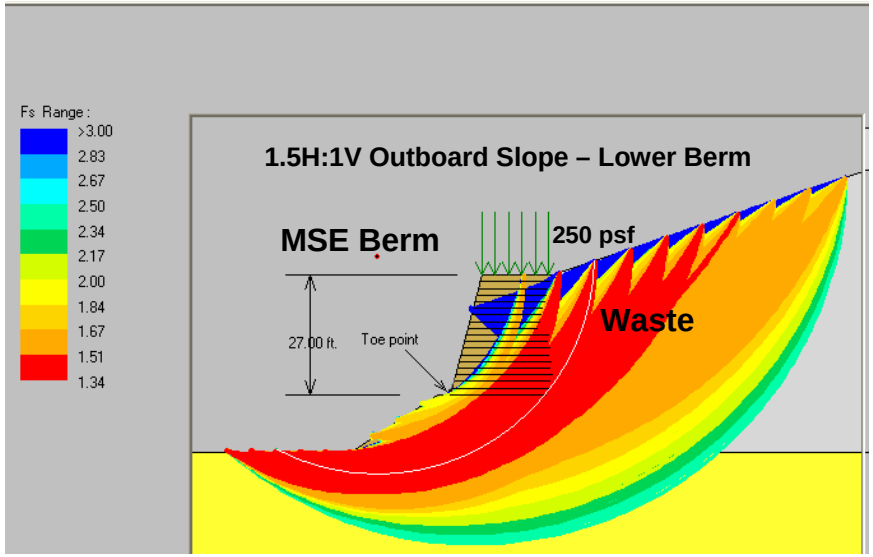
Sincerely yours,
GEOCOMP CORPORATION

Martin Hawkes, P.E.
Project Engineer

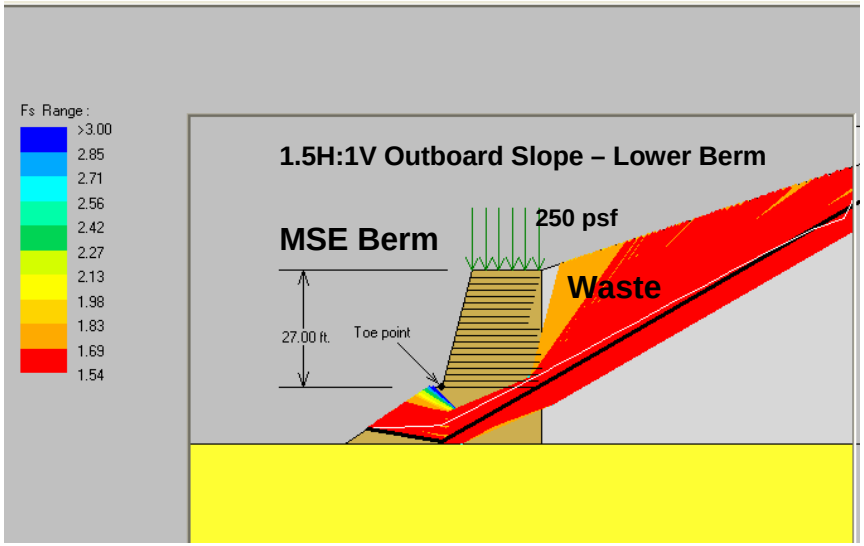
Attachments: Perimeter Berm Summary od Stability Analysis

Laboratory Test data

Circular Failure



Non-Circular Failure



Notes: 1. Length of reinforcement = 22 ft. bottom/16 ft. top.
2. Ultimate strength of reinforcement = 4,000 lb/ft bottom 6 layers; 3,000 lb/ft top 12 layers [vertical spacing = 18 in.].

Geocomp Corporation

Crow Lane Landfill
Newburyport, MA

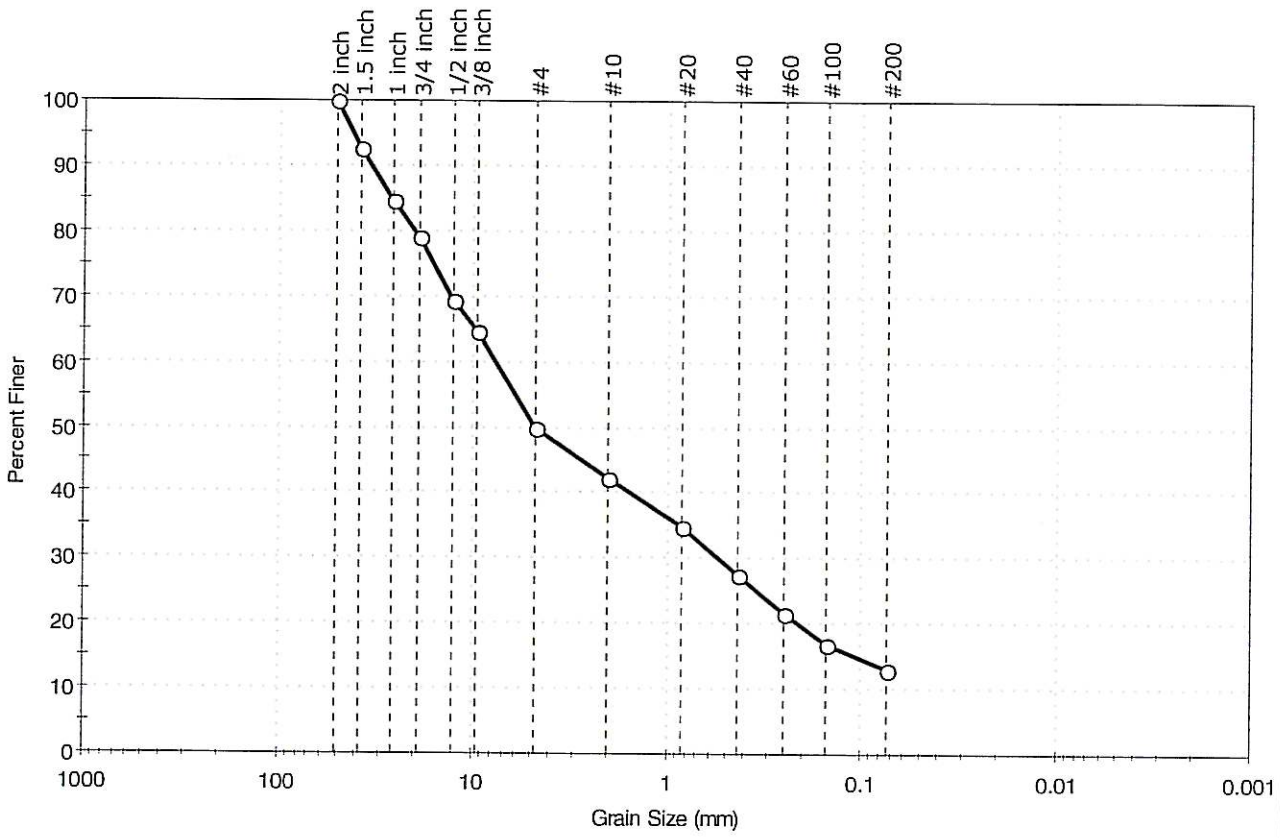
Summary of Stability Analyses

January 2007

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	Geocomp Consulting				
Project:	Crow Lane Landfill				
Location:	Newburyport, Ma			Project No:	GTX-7199
Boring ID:	---	Sample Type:	bag	Tested By:	mll
Sample ID:	P2-3	Test Date:	12/19/06	Checked By:	mcm
Depth :	---	Test Id:	104950		
Test Comment:	---				
Sample Description:	Dry, reddish gray, silty gravel with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	50.1	37.0	12.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
2 inch	50.80	100		
1.5 inch	38.10	93		
1 inch	25.70	85		
3/4 inch	19.00	79		
1/2 inch	12.70	69		
3/8 inch	9.51	64		
#4	4.75	50		
#4	4.75	50		
#10	2.00	42		
#20	0.84	35		
#40	0.42	28		
#60	0.25	22		
#100	0.15	17		
#200	0.074	13		

Coefficients

D_{85} = 26.1302 mm D_{30} = 0.5340 mm
D_{60} = 7.6798 mm D_{15} = 0.1081 mm
D_{50} = 4.7632 mm D_{10} = 0.0437 mm
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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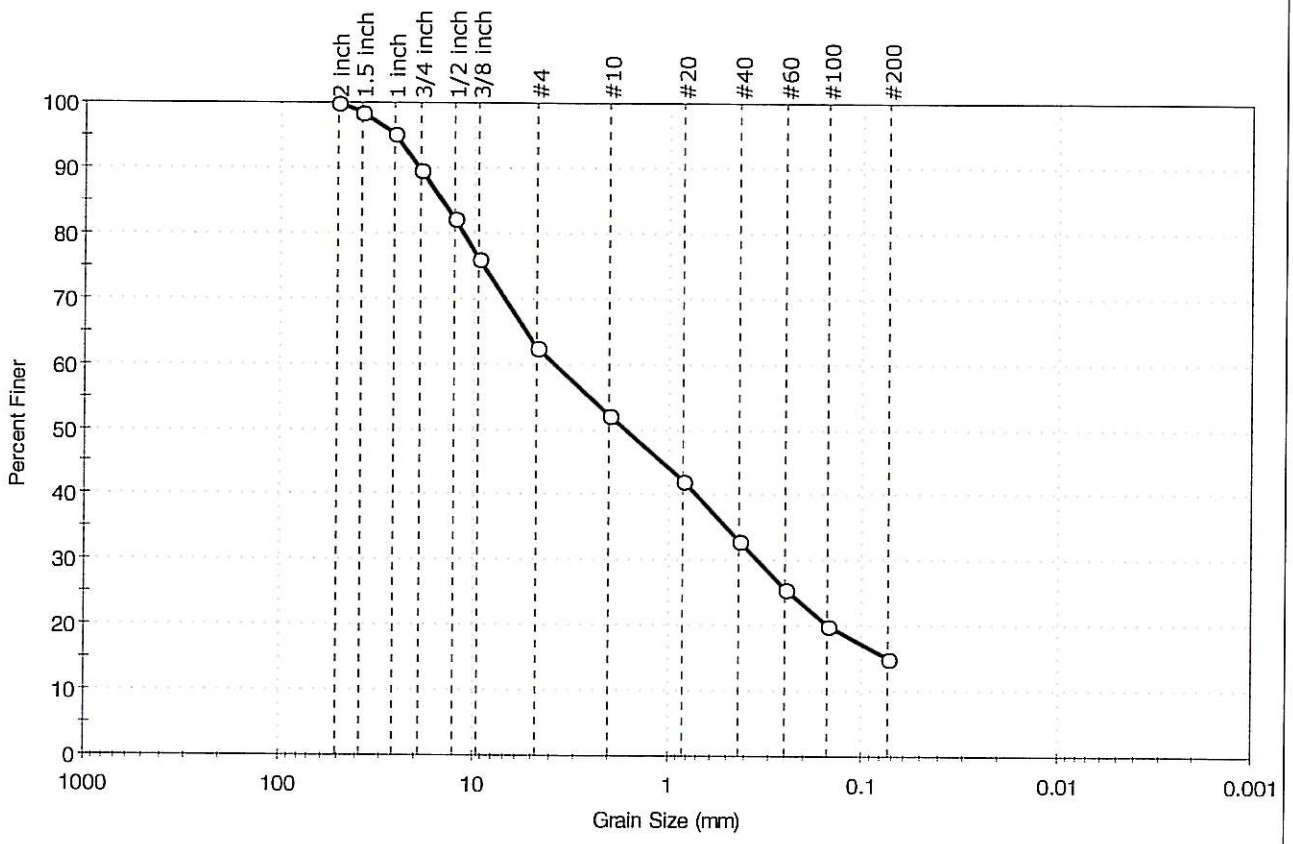
GeoTesting express
a subsidiary of Geocomp Corporation

Client:	Geocomp Consulting				
Project:	Crow Lane Landfill				
Location:	Newburyport, Ma			Project No:	GTX-7199
Boring ID:	---	Sample Type:	bag	Tested By:	mll
Sample ID:	P2-6	Test Date:	12/19/06	Checked By:	mcm
Depth :	---	Test Id:	104951		
Test Comment:	---				
Sample Description:	Moist, dark grayish brown silty sand with gravel				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



%Cobble	%Gravel	%Sand	%Silt & Clay Size
—	37.4	47.5	15.1

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
2 inch	50.80	100		
1.5 inch	38.10	99		
1 inch	25.70	95		
3/4 inch	19.00	90		
1/2 inch	12.70	82		
3/8 inch	9.51	76		
#4	4.75	63		
#10	2.00	52		
#20	0.84	42		
#40	0.42	33		
#60	0.25	26		
#100	0.15	20		
#200	0.074	15		

Coefficients

D_{85} = 14.6622 mm D_{30} = 0.3426 mm
D_{60} = 3.8108 mm D_{15} = N/A
D_{50} = 1.6418 mm D_{10} = N/A
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-b (0))

Sample/Test Description

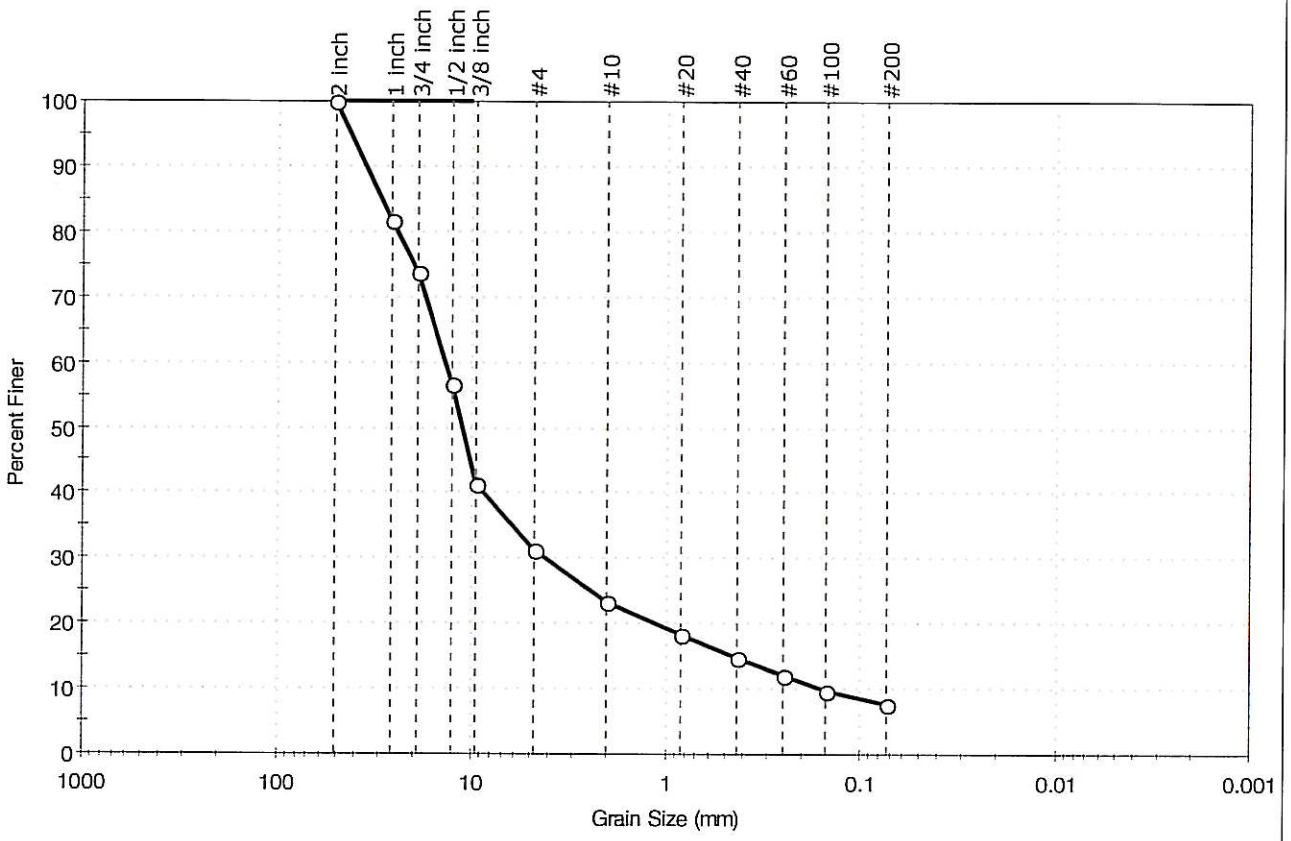
Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	Geocomp Consulting				
Project:	Crow Lane Landfill				
Location:	Newburyport, Ma			Project No:	GTX-7199
Boring ID:	---	Sample Type:	bag	Tested By:	mll
Sample ID:	P2-9	Test Date:	12/21/06	Checked By:	mcm
Depth :	---	Test Id:	104952		
Test Comment:	---				
Sample Description:	Dry,brown, gravel with silt and sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



%Cobble	%Gravel	%Sand	%Silt & Clay Size
—	68.6	23.6	7.8

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
	0.00	100		
2 inch	50.80	100		
1 inch	25.70	82		
3/4 inch	19.00	74		
1/2 inch	12.70	57		
3/8 inch	9.51	41		
#4	4.75	31		
#10	2.00	23		
#20	0.84	18		
#40	0.42	15		
#60	0.25	12		
#100	0.15	10		
#200	0.074	8		

Coefficients

D_{85} = 28.9662 mm	D_{30} = 4.1013 mm
D_{60} = 13.7584 mm	D_{15} = 0.4459 mm
D_{50} = 11.2138 mm	D_{10} = 0.1583 mm
C_u = 86.913	C_c = 7.723

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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GeoTesting express
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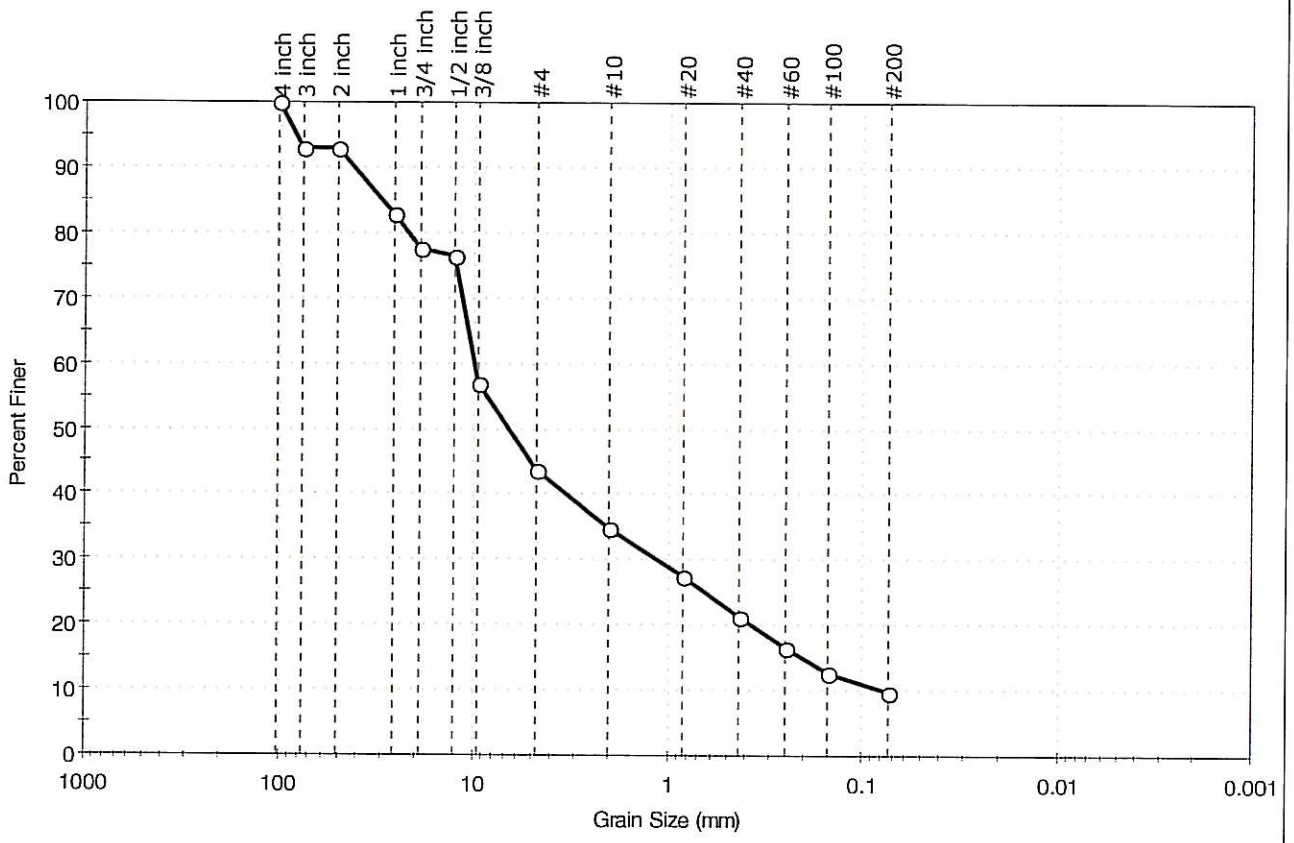
Client:	Geocomp Consulting				
Project:	Crow Lane Landfill				
Location:	Newburyport, Ma			Project No:	GTX-7199
Boring ID:	---	Sample Type:	bag	Tested By:	mll
Sample ID:	P1-3	Test Date:	12/21/06	Checked By:	mcm
Depth :	---	Test Id:	104953		
Test Comment:	---				
Sample Description:	Dry,dark reddish gray gravel with silt and sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
7.0	49.3	34.0	9.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
4 inch	101.60	100		
3 inch	76.10	93		
2 inch	50.80	93		
1 inch	25.70	83		
3/4 inch	19.00	78		
1/2 inch	12.70	76		
3/8 inch	9.51	57		
#4	4.75	44		
#10	2.00	35		
#20	0.84	28		
#40	0.42	21		
#60	0.25	16		
#100	0.15	13		
#200	0.074	10		

Coefficients

D_{85} = 29.5747 mm	D_{30} = 1.1323 mm
D_{60} = 9.9642 mm	D_{15} = 0.2070 mm
D_{50} = 6.6222 mm	D_{10} = 0.0803 mm
C_u = 124.087	C_c = 1.602

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

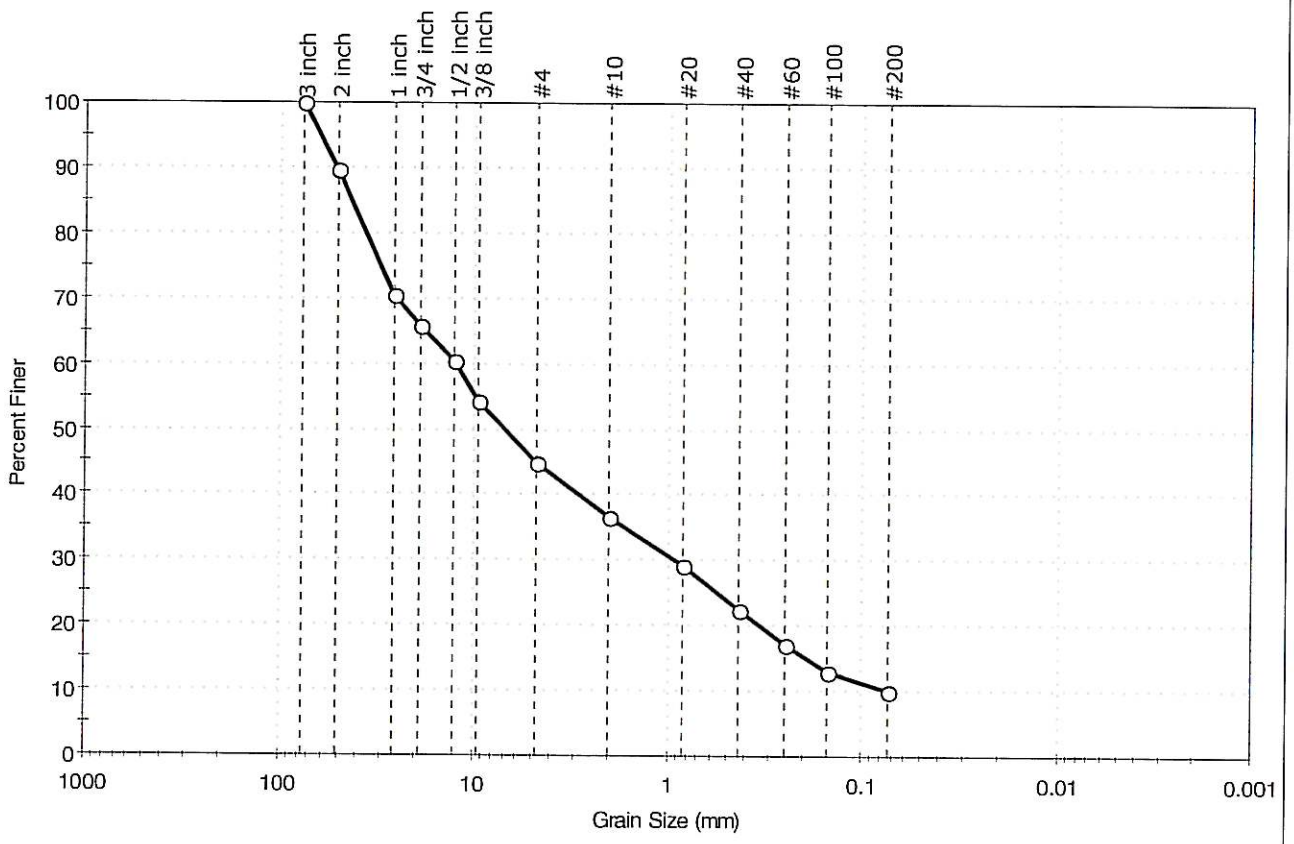
Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	Geocomp Consulting				
Project:	Crow Lane Landfill				
Location:	Newburyport, Ma			Project No:	GTX-7199
Boring ID:	---	Sample Type:	bag	Tested By:	mll
Sample ID:	P1-6	Test Date:	12/21/06	Checked By:	mcm
Depth :	---	Test Id:	104954		
Test Comment:	---				
Sample Description:	Dry, very dark gray, gravel with silt and sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
--	55.2	34.8	10.0

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3 inch	76.10	100		
2 inch	50.80	90		
1 inch	25.70	71		
3/4 inch	19.00	66		
1/2 inch	12.70	60		
3/8 inch	9.51	54		
#4	4.75	45		
#10	2.00	37		
#20	0.84	29		
#40	0.42	22		
#60	0.25	17		
#100	0.15	13		
#200	0.074	10		

Coefficients

D_{85} = 42.8454 mm D_{30} = 0.9274 mm
D_{60} = 12.4263 mm D_{15} = 0.1941 mm
D_{50} = 6.9598 mm D_{10} = 0.0749 mm
C_u = 165.905 C_c = 0.924

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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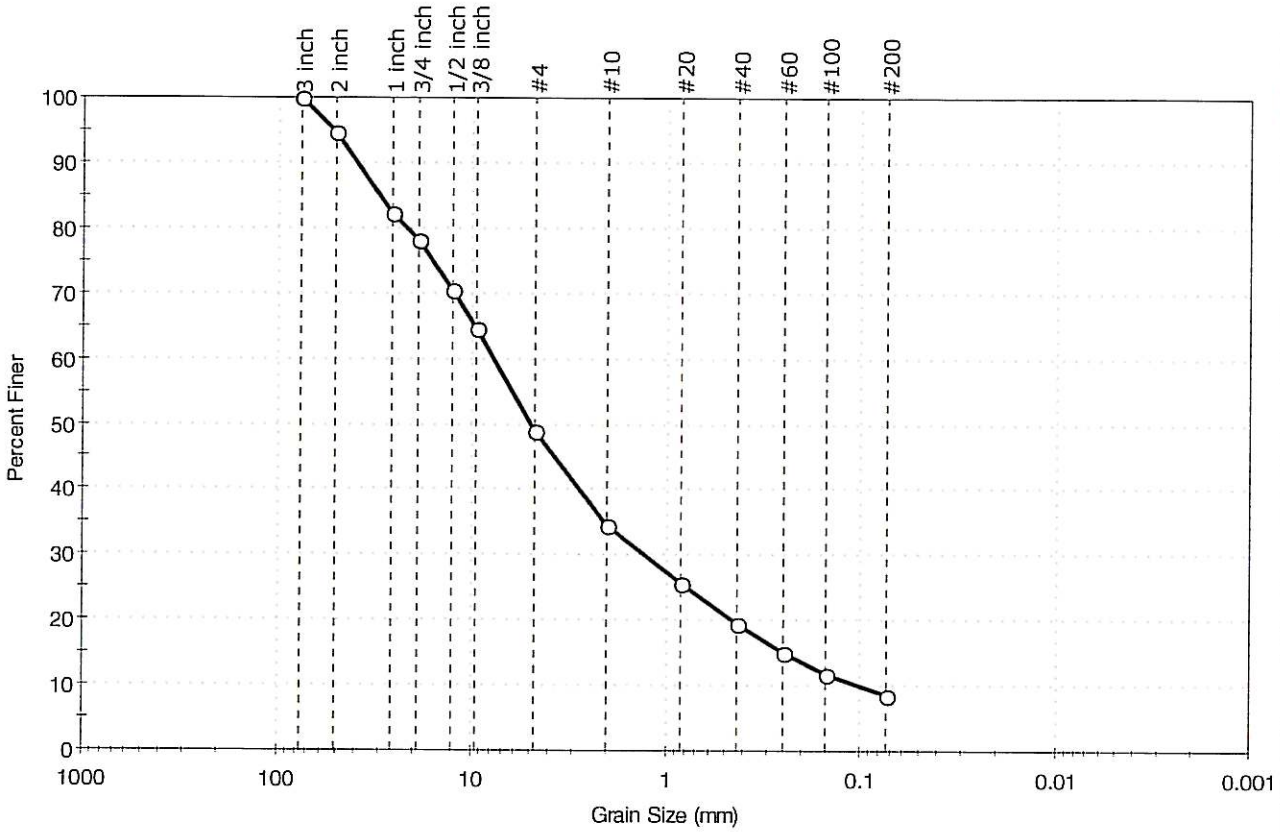
Client:	Geocomp Consulting				
Project:	Crow Lane Landfill				
Location:	Newburyport, Ma			Project No:	GTX-7199
Boring ID:	---	Sample Type:	bag	Tested By:	mll
Sample ID:	P1-9	Test Date:	12/21/06	Checked By:	mcm
Depth :	---	Test Id:	104955		
Test Comment:	---				
Sample Description:	Dry,light brownish gray, gravel with silt and sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	51.0	40.4	8.6

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3 inch	76.10	100		
2 inch	50.80	95		
1 inch	25.70	82		
3/4 inch	19.00	78		
1/2 inch	12.70	71		
3/8 inch	9.51	65		
#4	4.75	49		
#10	2.00	35		
#20	0.84	26		
#40	0.42	20		
#60	0.25	15		
#100	0.15	12		
#200	0.074	9		

Coefficients

D_{85} = 29.9593 mm D_{30} = 1.2870 mm
D_{60} = 7.7178 mm D_{15} = 0.2446 mm
D_{50} = 4.9720 mm D_{10} = 0.1025 mm
C_u = 75.296 C_c = 2.094

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

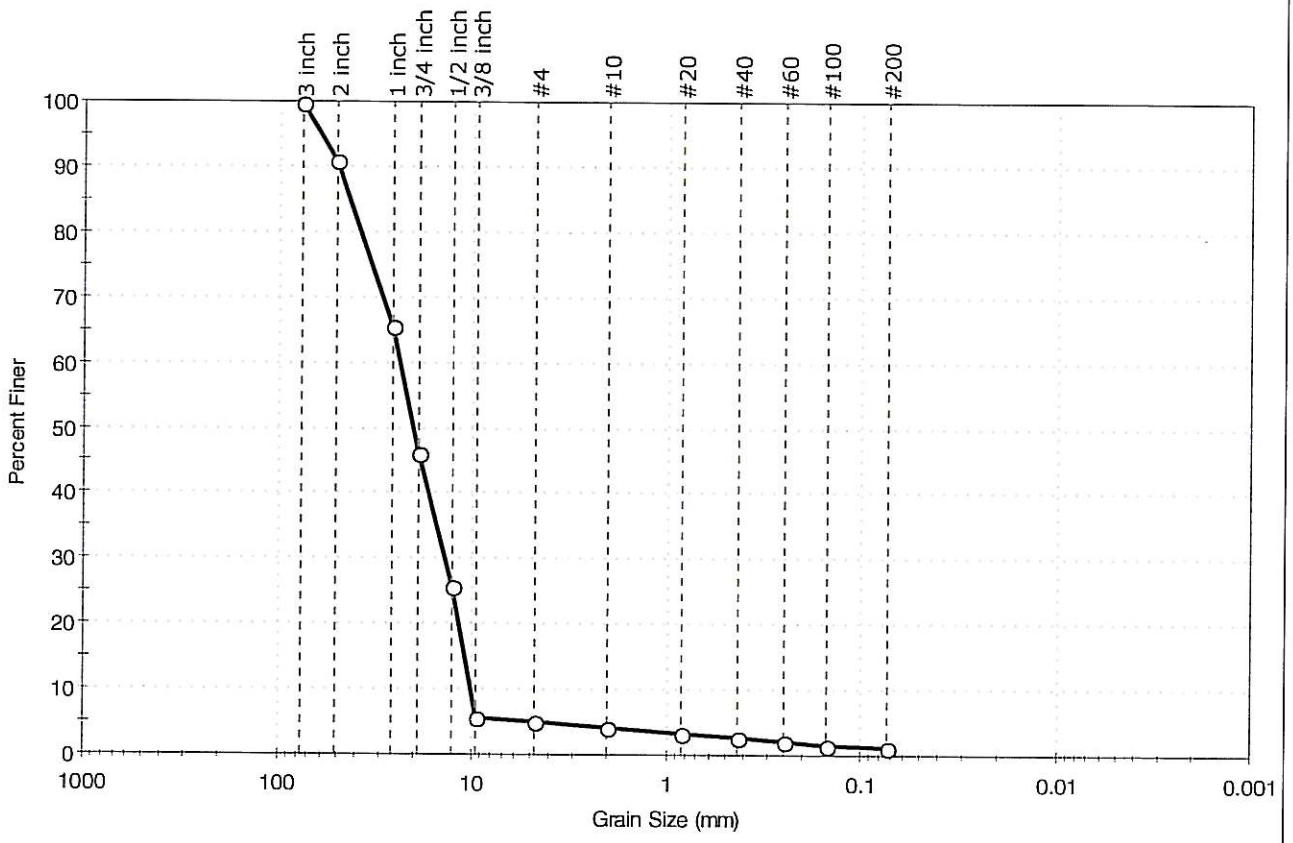
Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	Geocomp Consulting				
Project:	Crow Lane Landfill				
Location:	Newburyport, Ma			Project No:	GTX-7199
Boring ID:	---	Sample Type:	bag	Tested By:	mll
Sample ID:	P16-3	Test Date:	12/20/06	Checked By:	mcm
Depth :	---	Test Id:	104956		
Test Comment:	---				
Sample Description:	Dry,very dark reddish gray, gravel				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
0.3	94.7	3.8	1.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3 inch	76.10	100		
2 inch	50.80	91		
1 inch	25.70	65		
3/4 inch	19.00	46		
1/2 inch	12.70	26		
3/8 inch	9.51	6		
#4	4.75	5		
#10	2.00	4		
#20	0.84	3		
#40	0.42	3		
#60	0.25	2		
#100	0.15	2		
#200	0.074	1		

Coefficients

D_{85} = 43.3267 mm D_{30} = 13.8568 mm
D_{60} = 23.6012 mm D_{15} = 10.9039 mm
D_{50} = 20.2014 mm D_{10} = 10.1447 mm
C_u = 2.326 C_c = 0.802

Classification

ASTM Poorly graded gravel (GP)

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

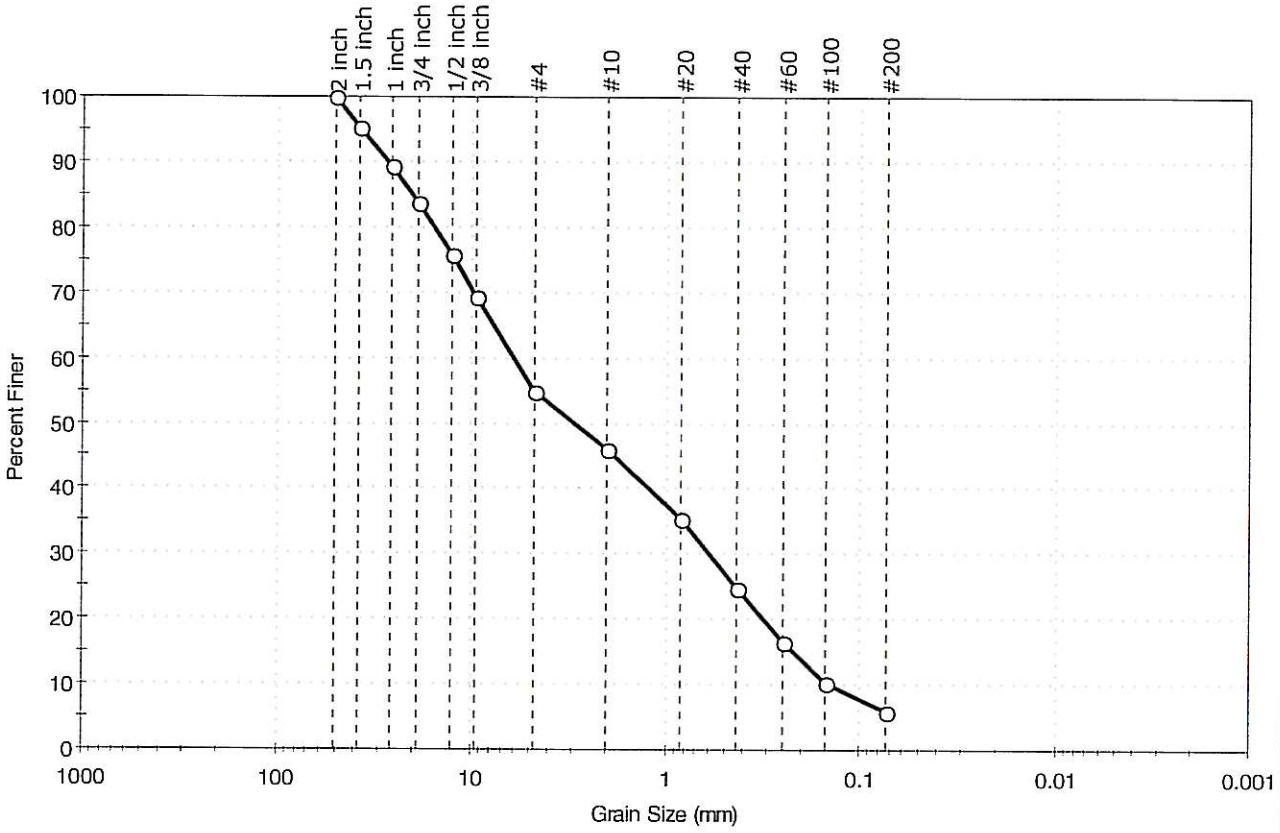
Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	Geocomp Consulting				
Project:	Crow Lane Landfill				
Location:	Newburyport, Ma			Project No:	GTX-7199
Boring ID:	---	Sample Type:	bag	Tested By:	mll
Sample ID:	P16-6	Test Date:	12/20/06	Checked By:	mcm
Depth :	---	Test Id:	104957		
Test Comment:	---				
Sample Description:	Dry, gray sand with silt and gravel				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	45.2	48.9	5.9

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
2 inch	50.80	100		
1.5 inch	38.10	95		
1 inch	25.70	90		
3/4 inch	19.00	84		
1/2 inch	12.70	76		
3/8 inch	9.51	69		
#4	4.75	55		
#10	2.00	46		
#20	0.84	35		
#40	0.42	25		
#60	0.25	17		
#100	0.15	10		
#200	0.074	6		

Coefficients

D_{85} = 20.1980 mm D_{30} = 0.5961 mm
D_{60} = 6.0904 mm D_{15} = 0.2199 mm
D_{50} = 2.9544 mm D_{10} = 0.1409 mm
C_u = 43.225 C_c = 0.414

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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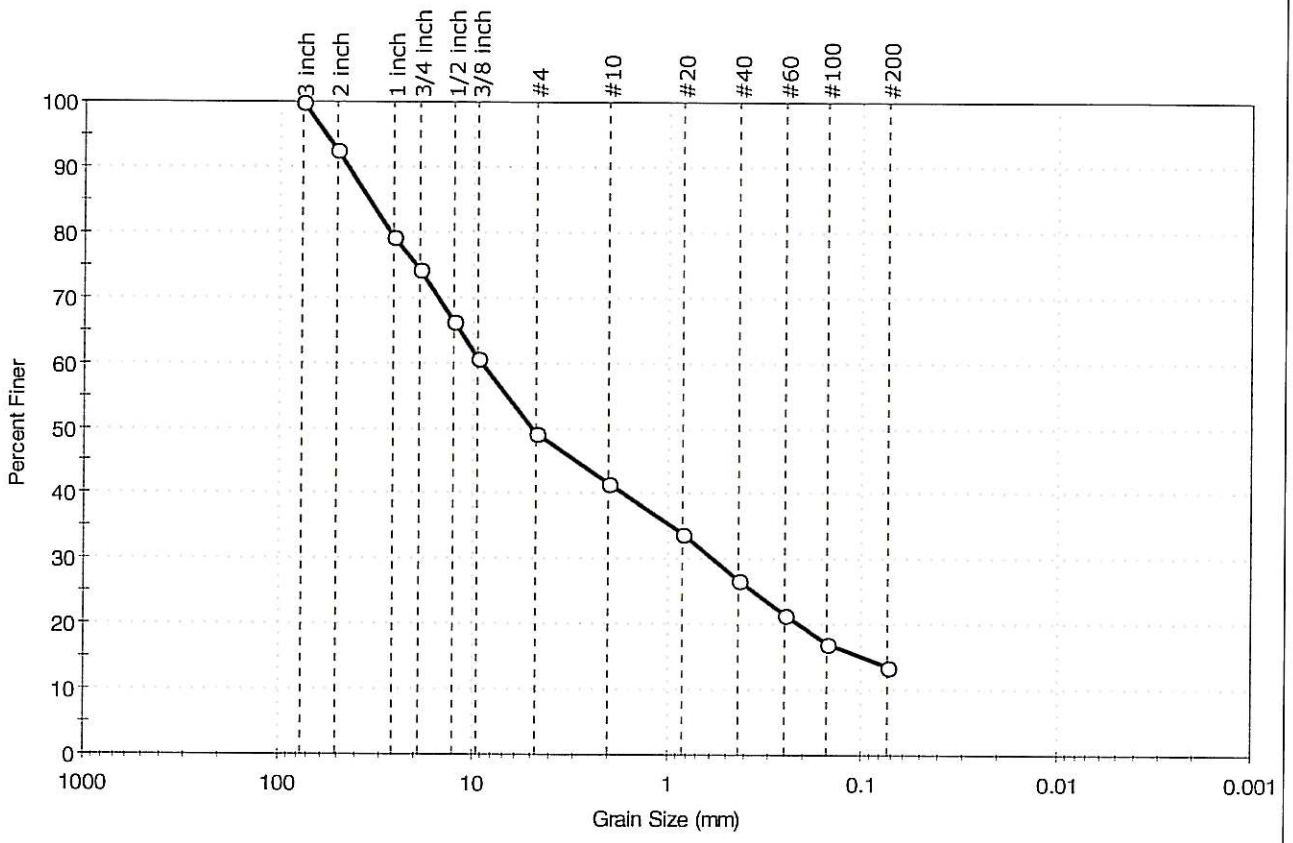
GeoTesting express
a subsidiary of Geocomp Corporation

Client:	Geocomp Consulting				
Project:	Crow Lane Landfill				
Location:	Newburyport, Ma			Project No:	GTX-7199
Boring ID:	---	Sample Type:	bag	Tested By:	mll
Sample ID:	P16-9	Test Date:	12/19/06	Checked By:	mcm
Depth :	---	Test Id:	104958		
Test Comment:	---				
Sample Description:	Dry, brown, sandy gravel with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
---	50.6	35.9	13.5

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3 inch	76.10	100		
2 inch	50.80	93		
1 inch	25.70	79		
3/4 inch	19.00	74		
1/2 inch	12.70	67		
3/8 inch	9.51	61		
#4	4.75	49		
#10	2.00	42		
#20	0.84	34		
#40	0.42	27		
#60	0.25	21		
#100	0.15	17		
#200	0.074	13		

Coefficients

D_{85} = 34.3378 mm	D_{30} = 0.5716 mm
D_{60} = 9.0579 mm	D_{15} = 0.1005 mm
D_{50} = 4.9258 mm	D_{10} = 0.0364 mm
C_u = N/A	C_c = N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

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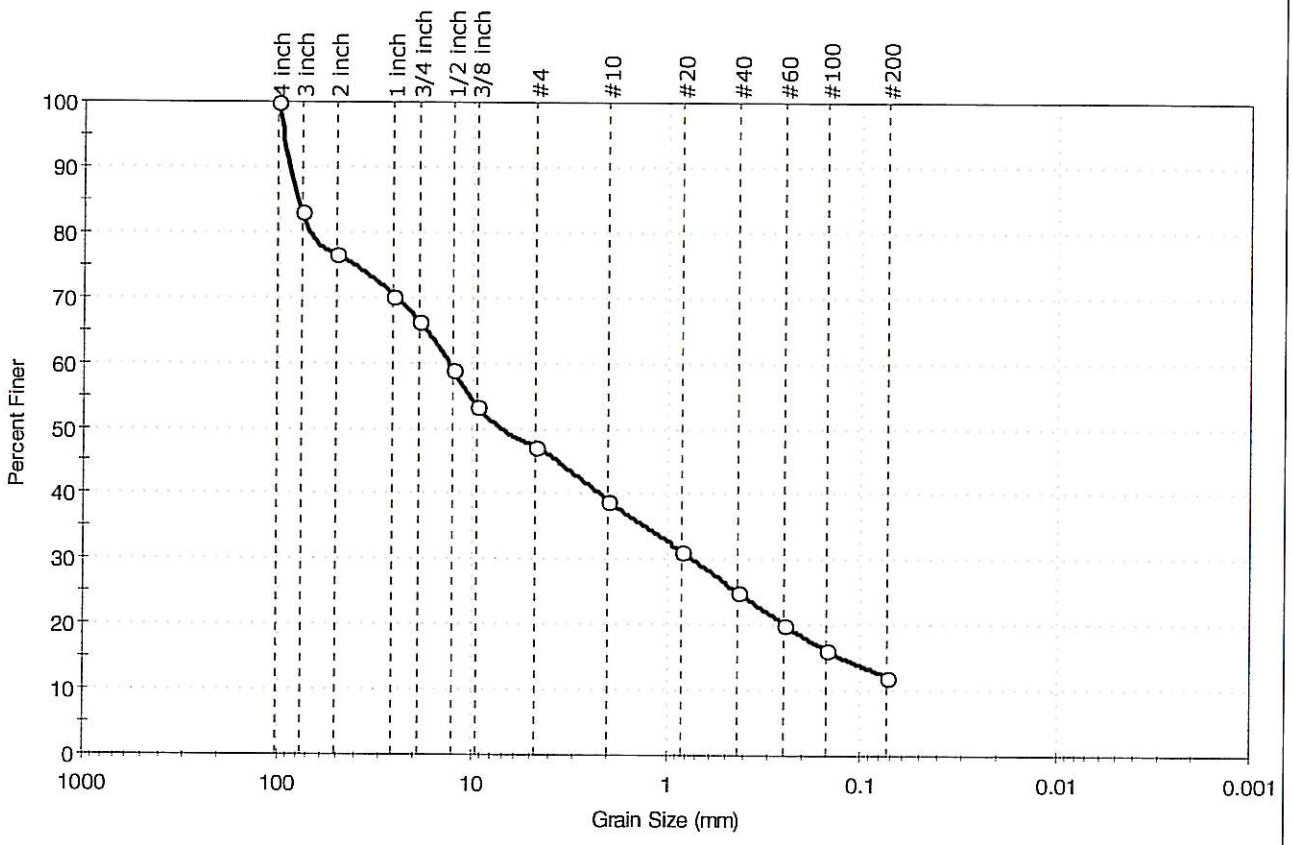
GeoTesting express
a subsidiary of Geocomp Corporation

Client:	Geocomp Consulting				
Project:	Crow Lane Landfill				
Location:	Newburyport, Ma			Project No:	GTX-7199
Boring ID:	---	Sample Type:	bag	Tested By:	mll
Sample ID:	P16-12	Test Date:	12/19/06	Checked By:	mcm
Depth :	---	Test Id:	104959		
Test Comment:	---				
Sample Description:	Dry, brown, silty gravel with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



% Cobble	% Gravel	% Sand	% Silt & Clay Size
16.8	36.0	35.0	12.2

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
4 inch	101.60	100		
3 inch	76.10	83		
2 inch	50.80	77		
1 inch	25.70	70		
3/4 inch	19.00	66		
1/2 inch	12.70	59		
3/8 inch	9.51	53		
#4	4.75	47		
#10	2.00	39		
#20	0.84	31		
#40	0.42	25		
#60	0.25	20		
#100	0.15	16		
#200	0.074	12		

Coefficients

D_{85} = 78.4842 mm D_{30} = 0.7325 mm
D_{60} = 13.4081 mm D_{15} = 0.1220 mm
D_{50} = 6.5124 mm D_{10} = 0.0494 mm
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

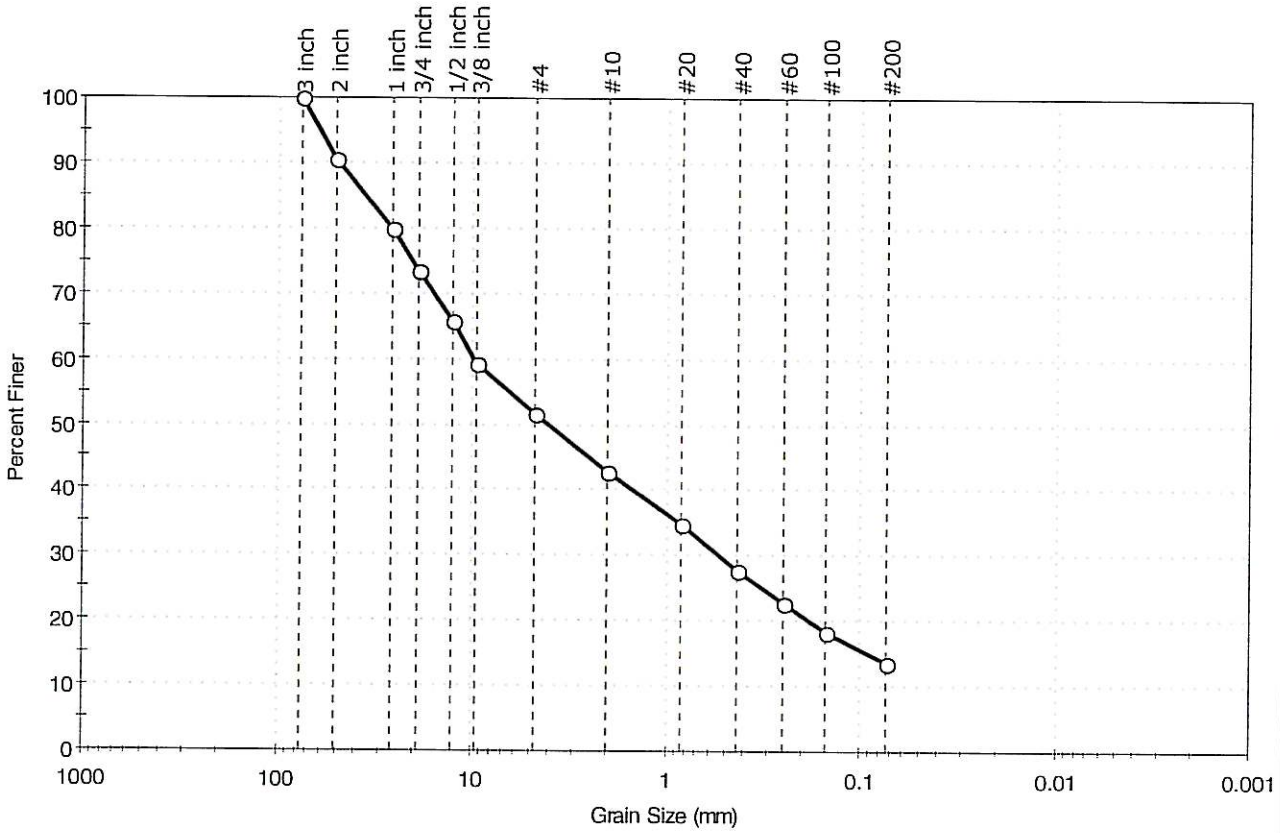
Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

GeoTesting express
a subsidiary of Geocomp Corporation

Client:	Geocomp Consulting				
Project:	Crow Lane Landfill				
Location:	Newburyport, Ma			Project No:	GTX-7199
Boring ID:	---	Sample Type:	bag	Tested By:	mll
Sample ID:	P16-15	Test Date:	12/18/06	Checked By:	mcm
Depth :	---	Test Id:	104960		
Test Comment:	---				
Sample Description:	Dry, brown, silty gravel with sand				
Sample Comment:	---				

Particle Size Analysis - ASTM D 422-63 (reapproved 2002)



%Cobble	%Gravel	%Sand	%Silt & Clay Size
--	48.3	38.0	13.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
3 inch	76.10	100		
2 inch	50.80	90		
1 inch	25.70	80		
3/4 inch	19.00	74		
1/2 inch	12.70	66		
3/8 inch	9.51	59		
#4	4.75	52		
#10	2.00	43		
#20	0.84	35		
#40	0.42	28		
#60	0.25	23		
#100	0.15	18		
#200	0.074	14		

Coefficients

D_{85} = 35.7373 mm D_{30} = 0.5238 mm
D_{60} = 9.8323 mm D_{15} = 0.0909 mm
D_{50} = 4.0197 mm D_{10} = 0.0410 mm
C_u = N/A C_c = N/A

Classification

ASTM N/A

AASHTO Stone Fragments, Gravel and Sand (A-1-a (0))

Sample/Test Description

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD